What is claimed is:

1. A device comprising:

a first magnetic region;

a second magnetic region;

a control region that forms a first interface with the first magnetic region and a second interface with the second magnetic region; and

a wire positioned relative to the control region so that a current through the wire creates in the control region a magnetic field that rotates spins of the electrons traversing the control region.

2. The device of claim 1, wherein the control region is such that an electron spin relaxation time of the control region is longer than a transit time of the electrons traversing control region.

3. The device of claim 1, wherein the control region comprises a semiconductor material.

4. The device of claim 3, wherein the semiconductor material is selected from a group consisting of Si, Ge, GaAs, InAs, GaP, GaInAs, ZnSe, and ZnCdSe.

5. The device of claim 3, wherein the semiconductor material is n-type.

6. The device of claim 1, wherein each of the first and second magnetic regions comprises a ferromagnetic material.

7. The device of claim 1, wherein the first magnetic region has a first magnetization, the second magnetic region has a second magnetization, and the first and second magnetizations are fixed at a relative angle selected to give the device a desired electrical characteristic.

8. The device of claim 1, further comprising terminals that permit biasing of the first and second magnetic regions to cause injection of spin-polarized electrons through the first

interface into the control region so that the second interface acts as a spin filter with a resistance depending on spin orientation of the spin-polarized electrons in the control region, near the second interface.

9. The device of claim 1, wherein a bias voltage applied between the first and second magnetic regions causes injection of spin-polarized electrons through the control region between the first magnetic region and the second magnetic region.

10. The device of claim 1, wherein a fixed bias voltage is applied between the first and second magnetic region, and a first current through the wire changes a second current between the first and second magnetic regions.

11. The device of claim 1, further comprising an insulating material disposed to electrically insulate the wire from the control region, the first magnetic region, and the second magnetic region.

12. A device comprising:

a magnetic wire;

a magnetic region; and

a control region forming a first interface with the magnetic wire and a second interface with the magnetic regions, wherein:

the first and second interfaces selectively permit spin-polarized electrons to cross between the magnetic wire and the magnetic region; and

a current along the magnetic wire creates in the control region a magnetic field that rotates spins of the electrons traversing the control region.

13. The device of claim 12, wherein the control region is such that an electron spin relaxation time of the control region is longer than a transit time of the electrons traversing control region.

14. The device of claim 12, wherein the control region comprises a semiconductor material.

15. The device of claim 14, wherein the semiconductor material is selected from a group consisting of Si, Ge, GaAs, InAs, InP, GaInAs, ZnSe, and ZnCdSe.

16. The device of claim 14, wherein the semiconductor material is n-type.

17. The device of claim 12, wherein the magnetic wire comprises a ferromagnetic material.

18. The device of claim 12, wherein the magnetic region comprises a ferromagnetic material.

19. The device of claim 12, wherein the magnetic wire has a first magnetization, the magnetic region has a second magnetization, and the first and second magnetizations are fixed at a relative angle selected to give the device a desired electrical characteristic.

20. The device of claim 12, wherein a bias voltage applied between the magnetic wire and the magnetic region causes injection of spin-polarized electrons through the control region between the magnetic wire and the magnetic region.

21. The device of claim 12, wherein a fixed bias voltage is applied between the magnetic wire and the magnetic region, and a first current through the magnetic wire changes a second current between the magnetic wire and the magnetic region.

22. A method for ultrafast operation of a spin injection device, comprising:

injecting spin-polarized electrons from a first magnetic region through a semiconductor region to second magnetic region; and

driving an electrical current to create a magnetic field inside the semiconductor region, causing spin precession of the injected spin-polarized electrons inside the semiconductor region.

23. The method of claim 22, wherein injecting provides spin ballistic transport of spin-polarized electrons through the semiconductor region.

24. The method of claim 22, wherein the current is driven through a wire having a thickness less than 100 nm.

25. The method of claim 24, wherein the wire is a semi-cylindrical layer of a thickness less than 100 nm.

26. The method of claim 24, wherein the wire comprises a magnetic material that forms one of the first magnetic region and the second magnetic region.

27. The method of claim 22, further comprising selecting an angle between a first magnetization of the first magnetic layer and a second magnetization of the second magnetic layer, wherein the angle is selected according to a desired function of the spin injection device.

28. A device fabrication process comprising:

forming a trench in a substrate;

depositing a first magnetic layer in the trench;

depositing a semiconductor layer on the first magnetic layer;

depositing a second magnetic layer on the semiconductor layer;

forming an insulating layer on the second magnetic layer;

forming a wire of conductive material on the insulating layer; and

forming a first contact to the first magnetic layer, a second contact to the second magnetic layer, a third contact to one end of the wire, and a fourth contact to another end of the wire.

29. The process of claim 28, wherein the first magnetic layer, the semiconductor layer, the second magnetic layer, the insulating layer, and the wire are within the trench.

30. The process of claim 28, wherein the wire has a radius less than 100 nm.

31. The process of claim 30, wherein the wire has a length greater than 0.1 μm.

32. The process of claim 28, wherein the semiconductor layer comprises a conformal

layer having a thickness less than about 100 nm.

33. A device fabrication process comprising:
forming a wire of conductive material on a substrate;
forming an insulating layer on the wire;
depositing a first magnetic layer on the insulating layer;
depositing a semiconductor layer on the first magnetic layer;
depositing a second magnetic layer on the semiconductor layer; and
forming a first contact to the first magnetic layer, a second contact to the second magnetic layer, a third contact to one end of the wire, and a fourth contact to another end of the wire.

34. The process of claim 33, wherein the wire has a radius less than 100 nm.

35. The process of claim 34, wherein the wire has a length greater than 1 μm.

36. The process of claim 34, wherein each of the insulating layer, the first magnetic layer, the semiconductor layer, and the second magnetic layer is conformal layer that arches over the wire.

37. The process of claim 33, wherein the insulating layer is between 2 nm and 20 nm thick.

38. The process of claim 33, wherein the semiconductor layer has a thickness less than about 100 nm.